LAMPIRAN

8.1 Tabel Pengamatan

Run	Waktu (menit)	Bukaan Valve	Fluida Panas (°c)		Fluida Dingin (°c)	
			Th In	Th Out	Tc In	Tc Out
1	7	$^1/_4$	50	46	29	30
2	7	$^1/_2$	50	45	29	31
3	7	$^3/_4$	50	44	29	32
4	7	$^4/_4$	50	40	29	34

8.2 Hasil Perhitungan

8.2.1 Percobaan pertama

Shell side

IDs = 10 in

B = 7

Baffle space = 6 in

Passes = 1

Pt = 0,9375

C = 0, 99 (fig. 2 Kern)

de = 0,045833333 ft

Tube side

IDt = 0,62 in

ODt = ¾

BWG = 16

pitch = triangular

passes= 2

C = 0,98 (fig2 Kern)

Nt = 12

Temperatur :

Th1 = 50 ^{O}C = 122 ^{O}F

Th2 = 46 ^{O}C = 114,8 ^{O}F

ΔTh = 4 ^{O}C = 7,2 ^{O}F

Tc1 = 29 ^{O}C = 84,2 ^{O}F

Tc2 = 30 ^{O}C = 86 ^{O}F

ΔTc = 1^{O}C = 1.8 ^{O}F

dimana :

A = 7080 cm^2

= 0,708 m^2

= 7,618 ft^2

$$\Delta TLMTD = \frac{(Th1-Tc2)-(Th2-Tc1)}{(\ln(Th1-Tc2)/(Th2-Tc1))}$$

$$= \frac{(122-86)-(113-84,2)}{(\ln(122-86)/(113-84,2))}$$

= 33,227 ^oF

1) Δt =

Hot fluid		cold fluid	Diff
122	Higher Temp	84,2	37,8
114,8	Lower Temp	86	28,8
7,2	Differences	1,8	9

L = 1 m

= 3,2808399ft

= 39,370079 in

LMTD = 32,266 ^oF

$$R = \frac{\Delta th}{\Delta tc} = \frac{7,2}{1,8} = 4$$

$$S = \frac{\Delta tc}{th1-tc2} = \frac{1,8}{122-114,8} = 0,50$$

Ft = 0,98 (Fig 18 Kern)

Δt = Ft x ΔTLMTD

= 0,98 x 32,227 ^{o}F

= 31,621^{o}F

Tube

Rumus $Tf_c = \frac{Tc\ out + Tc\ in}{2}$

$Tf_c = \frac{(86+84,2)}{2}$ = 85,1 F

Perhitungan Cp aliran dingin (Cp_c) dengan menggunakan interpolasi

Rumus $Cp_c = \frac{Tdiketahui - Tatas}{Tbawah - Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah})

Cp_c = $\frac{(685,1-80)\text{F}}{(90-80)\text{F}}$ ((4,174-4,179)+4,179) Kj/kg F

= 2,04281 Kj/kg F

m_c = 43 kg/jam

Perhitungan kapasitas panas aliran dingin (C_c)

Rumus $C_c = m_c$ x Cp_c

C_c = 43 kg/jam x 2,04281 Btu/kg F

= 87 Btu/jam F

Perhitungan laju perpindahan panas aliran dingin (Q_c)

Rumus $Q_c = m_c$ x C_c x ΔT_c

Q_c = 43kg/jam x87 Btu/jam F x 32,562 ^{o}F

= 119437.1 btu kg/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD = $\frac{Q}{A\ X \Delta \text{TLMTD}}$

UD = $\frac{119437,1}{7,618\ X\ 33,227}$

UD = 485.8984 btu kg /jamft^2 ^{o}F

UD Desain = 500 btu kg /jamft^2 ^{o}F

Shell

Perhitungan temperature aliran panas rata-rata (Tf_h)

Rumus $Tf_h = \frac{Th\ in+Th\ out}{2}$

$Tf_h = \frac{(114,8+122)}{2}$ = 118,4 F

Perhitungan Cp aliran panas (Cp_h) dengan menggunakan interpolasi

Rumus $Cp_h = \frac{Tdiketahui-Tatas}{Tbawah-Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah}

Cp_c = $\frac{(118,4-100)\text{F}}{(130-100)\text{F}}$ ((4,174-4,179)+4,179) btu/kg F

= 2,560053 btu/kg F

m_h = 38,3 kg/det

Perhitungan kapasitas panas aliran panas (C_h)

Rumus $C_h = m_h$ x Cp_h

C_h = 38,3 kg/jam x 2,560053 btu/kg F

= 98,05004 btu/jam F

Perhitungan laju perpindahan panas aliran panas (Q_h)

Rumus $Q_h = m_h \times C_h \times \Delta T_h$

Q_h = 38,3 kg/jam x 98,05004 btu/jam F x 32,562 ^oF

= 122282 btu/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD = $\frac{Q}{A\ X \Delta \mathrm{TLMTD}}$

UD = $\frac{122282}{7{,}618\ X\ 33{,}227}$

UD = 483.089 btu kg /jamft^2 ^oF

UD Desain = 500 btu kg /jamft^2 ^oF

8.2.2 Percobaan Kedua

Shell side

IDs = 10 in

B = 7

Baffle space = 6 in

Passes = 1

Pt = 0,9375

C = 0, 99 (fig. 2 Kern)

de = 0,0458 ft

Tube side

IDt = 0,62 in

ODt = ¾

BWG = 16

pitch = triangular

passes= 2

C = 0,98 (fig2 Kern)

Nt = 12

Temperatur :

Th1 = 50 ^{O}C = 122 ^{O}F

Th2 = 45 ^{O}C = 113^{O}F

ΔTh = 5 ^{O}C = 9 ^{O}F

Tc1 = 29 ^{O}C = 84,2 ^{O}F

Tc2 = 31 ^{O}C = 87,8 ^{O}F

ΔTc = 2 ^{O}C = 3,6 ^{O}F

A = 7080 cm^2

= 0,708 m^2

= 7,618 ft^2

$$\Delta TLMTD = \frac{(Th1-Tc2)-(Th2-Tc1)}{(\ln(Th1-Tc2)/(Th2-Tc1))}$$

$$= \frac{(122-87{,}8)-(113-84{,}2)}{(\ln(122-87{,}8)/(113-84{,}2))}$$

= 31,423 ^oF

2) Δt =

Hot fluid		cold fluid	Diff
122	Higher Temp	84,2	37,8
113	Lower Temp	87,8	25,2
9	Differences	3,6	12,6

L = 1 m

= 3,2808399ft

= 39,370079 in

LMTD = 31,423 ^oF

$$R = \frac{\Delta th}{\Delta tc} = \frac{9}{3{,}6} = 2$$

$$S = \frac{\Delta tc}{th1-tc2} = \frac{3{,}6}{122-87{,}8} = 0{,}105$$

Ft = 0,98 (Fig 18 Kern)

Δt = Ft x ΔTLMTD

= 0,98 x 31,423 ^{o}F

= 30,794 ^{o}F

1. Perhitungan temperature aliran dingin rata-rata (Tf_c)

   Rumus $Tf_c = \frac{Tc\ out + Tc\ in}{2}$

Tube

$Tf_c = \frac{(87,8+84,2)}{2}$ = 86 F

Perhitungan Cp aliran dingin (Cp_c) dengan menggunakan interpolasi

Rumus $Cp_c = \frac{Tdiketahui - Tatas}{Tbawah - Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah})

$Cp_c = \frac{(86-90)F}{(80-90)F}$ ((4,174-4,179)+4,179) Btu/kg F

= 1.6676 Btu/kg F

m_c = 47,2 kg/jam

Perhitungan kapasitas panas aliran dingin (C_c)

Rumus $C_c = m_c$ x Cp_c

C_c = 47,2 kg/jam x 1,6676 btu/kg F

= 78.71072 Btu/jam F

Perhitungan laju perpindahan panas aliran dingin (Q_c)

Rumus $Q_c = m_c$ x C_c x ΔT_c

Q_c = 47,2 kg/jam x 78.71072 Btu/jam F x 30,794 ^{o}F

= 110893,9 Btu kg/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD = $\frac{Q}{A\ X \Delta \mathrm{TLMTD}}$

UD = $\frac{110893,9}{7,618\ X\ 31,423}$

UD = 477,9213 btu/jamft^2 ^{o}F

UD Desain = 500 btu/jamft^2 ^{o}F

Shell

Perhitungan temperature aliran panas rata-rata (Tf_h)

Rumus $Tf_h = \frac{Th\ in+Th\ out}{2}$

$Tf_h = \frac{(113+122)}{2}$ = 117,5 F

Perhitungan Cp aliran panas (Cp_h) dengan menggunakan interpolasi

Rumus $Cp_h = \frac{Tdiketahui-Tatas}{Tbawah-Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah}

Cp_c = $\frac{(117,5-100)\mathrm{F}}{(130-100)\mathrm{F}}$ ((4,174-4,179)+4,179) btu/kg F

= 2,434833 btu/kg F

m_h = 39 kg/jam

Perhitungan kapasitas panas aliran panas (C_h)

Rumus $C_h = m_h$ x Cp_h

C_h = 39 kg/jam x 2,434833 btu/kg F

= 94.9585 btu/jam F

Perhitungan laju perpindahan panas aliran panas (Q_h)

Rumus $Q_h = m_h$ x C_h x ΔT_h

Q_h = 39 kg/jam x 94,9585 btu/jam F x 30,794 ^oF

= 114042,9 btu/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD = $\frac{Q}{A\ X \Delta \mathrm{TLMTD}}$

UD = $\frac{114042,9}{7,618\ X\ 31,423}$

UD = 476,4079 btu kg /jamft^2 ^oF

UD Desain = 500 btu kg /jamft^2 ^oF

8.2.2 Percobaan Ketiga

Shell side

IDs = 10 in

B = 7

Baffle space = 6 in

Passes = 1

Pt = 0,9375

C = 0, 99 (fig. 2 Kern)

de = 0,045833333 ft

Tube side

IDt = 0,62 in

ODt = ¾

BWG = 16

pitch = triangular

passes= 2

C = 0,98 (fig2 Kern)

Nt = 12

Temperatur :

Th1 = 50 ^{O}C = 122 ^{O}F

Th2 = 44 ^{O}C = 111,2 ^{O}F

ΔTh = 6 ^{O}C = 10,8 ^{O}F

Tc1 = 29 ^{O}C = 84,2 ^{O}F

Tc2 = 32 ^{O}C = 89,6 ^{O}F

ΔTc = 3 ^{O}C = 5,4 ^{O}F

A = 7080 cm^2

= 0,708 m^2

= 7,618 ft^2

$$\Delta TLMTD = \frac{(Th1-Tc2)-(Th2-Tc1)}{(\ln(Th1-Tc2)/(Th2-Tc1))}$$

$$= \frac{(122-89,6)-(111,2-84,2)}{(\ln(122-89,6)/(111,2-84,2))}$$

= 29,618 ^oF

3) Δt =

Hot fluid		cold fluid	Diff
122	Higher Temp	84,2	37,8
111,2	Lower Temp	89,6	19,8
10,8	Differences	5,4	18

L = 1 m

= 3,2808399ft

= 39,370079 in

LMTD = 29,618 ^oF

$$R = \frac{\Delta th}{\Delta tc} = \frac{12,6}{5,4} = 2$$

$$S = \frac{\Delta tc}{th1-tc2} = \frac{5,4}{122-89,6} = 0,167$$

Ft = 0,98 (Fig 18 Kern)

Δt = Ft x ΔTLMTD

= 0,98 x 29,618 ^oF

= 29,026^oF

Tube

Perhitungan temperature aliran dingin rata-rata (Tf_c)

Rumus $Tf_c = \frac{Tc\ out + Tc\ in}{2}$

$Tf_c = \frac{(89{,}6+84{,}2)}{2}$ = 86,9 F

Perhitungan Cp aliran dingin (Cp_c) dengan menggunakan interpolasi

Rumus $Cp_c = \frac{Tdiketahui - Tatas}{Tbawah - Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah})

$Cp_c = \frac{(86{,}9-90)\text{F}}{(80-90)\text{F}}$ ((4,174-4,179)+4,179) Btu/kg F

= 1,29239 btu/kg F

m_c = 53,14 kg/jam

Perhitungan kapasitas panas aliran dingin (C_c)

Rumus $C_c = m_c$ x Cp_c

C_c = 53,14 kg/jam x 1,29239 btu/kg F

= 68,6776 btu/jam F

Perhitungan laju perpindahan panas aliran dingin (Q_c)

Rumus $Q_c = m_c$ x C_c x ΔT_c

Q_c = 53,14 kg/jam x 68,6776 btu/jam F x 29,026 ^oF

= 102465,5 btu/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD $= \frac{Q}{A\ X \Delta \text{TLMTD}}$

UD $= \frac{102456,5}{7,618\ X\ 29,618}$

UD = 469,4802 btu kg/jamft^2 ^{o}F

UD Desain = 500 btu kg/jamft^2 ^{o}F

Shell

Perhitungan temperature aliran panas rata-rata (Tf_h)

Rumus $Tf_h = \frac{Th\ in+Th\ out}{2}$

$Tf_h = \frac{(111,2+122)}{2}$ = 116,6 F

Perhitungan Cp aliran panas (Cp_h) dengan menggunakan interpolasi

Rumus $Cp_h = \frac{Tdiketahui-Tatas}{Tbawah-Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah}

$Cp_c = \frac{(116,6-100)\text{F}}{(130-100)\text{F}}$ ((4,174-4,179)+4,179) btu/kg F

= 2,309613 btu/kg F

m_h = 40 kg/jam

Perhitungan kapasitas panas aliran panas (C_h)

Rumus $C_h = m_h$ x Cp_h

C_h = 45 kg/jam x 2,309613 btu/kg F

= 92,38453 btu/jam F

Perhitungan laju perpindahan panas aliran panas (Q_h)

Rumus $Q_h = m_h$ x C_h x ΔT_h

Q_h = 45 kg/jam x 92,38453 btu/jam F x 29,026 F

= 107260,8 btu/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD = $\frac{Q}{A\ X \Delta \mathrm{TLMTD}}$

UD = $\frac{107260,8}{7,618\ X\ 29,618}$

UD = 475,3788 btu kg /jamft^2 ^{o}F

UD Desain = 500 btu kg /jamft^2 ^{o}F

8.2.4 Percobaan Keempat

Shell side

IDs = 10 in

B = 7

Baffle space = 6 in

Passes = 1

Pt = 0,9375

C = 0, 99 (fig. 2 Kern)

de = 0,045833333 ft

Tube side

IDt = 0,62 in

ODt = ¾

BWG = 16

pitch = triangular

passes= 2

C = 0,98 (fig2 Kern)

Nt = 12

Temperatur :

Th1 = 50 ^{O}C = 112 ^{O}F

Th2 = 40 ^{O}C = 104 ^{O}F

ΔTh =10 ^{O}C = 18 ^{O}F

Tc1 = 29 ^{O}C = 84,2 ^{O}F

Tc2 = 34 ^{O}C = 93,2 ^{O}F

ΔTc = 5 ^{O}C = 9 ^{O}F

A = 7080 cm^2

= 0,708 m^2

= 7,618 ft^2

ΔTLMTD = $\frac{(\mathrm{Th1}-\mathrm{Tc2})-(\mathrm{Th2}-\mathrm{Tc1})}{(\ln(\mathrm{Th1}-\mathrm{Tc2})/(\mathrm{Th2}-\mathrm{Tc1}))}$

= $\frac{(122-93,2)-(104-84,2)}{(\ln(122-93,2)/(104-84,2)}$

= 24,020 ^{o}F

4) Δt =

Hot fluid		cold fluid	Diff
122	Higher Temp	84,2	37,8
104	Lower Temp	93,2	10,8
18	Differences	9	27

L = 1 m

= 3,2808399ft

= 39,370079 in

LMTD = 24,020 ^{o}F

R = $\frac{\Delta th}{\Delta tc} = \frac{18}{198}$ = 2

S = $\frac{\Delta tc}{th1-tc2} = \frac{9}{122-93,2}$ = 0,313

Ft = 0,98 (Fig 18 Kern)

Δt = Ft x ΔTLMTD

= 0,98 x 24,020 ^{o}F

= 23,539 ^{o}F

Tube

Perhitungan temperature aliran dingin rata-rata (Tf_c)

Rumus $Tf_c = \frac{Tc\ out + Tc\ in}{2}$

$Tf_c = \frac{(91,4+84,2)}{2}$ = 87,8 F

Perhitungan Cp aliran dingin (Cp_c) dengan menggunakan interpolasi

Rumus $Cp_c = \frac{Tdiketahui - Tatas}{Tbawah - Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah})

$Cp_c = \frac{(87,8-90)F}{(80-90)F}$ ((4,174-4,179)+4,179) btu/kg F

= 0,91718 btu/kg F

m_c = 60 kg/jam

Perhitungan kapasitas panas aliran dingin (C_c)

Rumus $C_c = m_c$ x Cp_c

C_c = 60 kg/jam x 0,91718 btu/kg F

= 55,0308 btu/jam F

Perhitungan laju perpindahan panas aliran dingin (Q_c)

Rumus $Q_c = m_c$ x C_c x ΔT_c

Q_c = 60 kg/jam x 55,0308 btu/jam F x 23,539 ^oF

= 81648,41 btu kg/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD = $\frac{Q}{A\ X \Delta TLMTD}$

UD = $\frac{86846,69}{7,618\ X\ 24,020}$

UD = 446.2064 btu kg/jamft^2 ^oF

UD Desain = 500 btu kg/jamft^2 ^oF

Shell

Perhitungan temperature aliran panas rata-rata (Tf_h)

Rumus $Tf_h = \frac{Th\ in+Th\ out}{2}$

$Tf_h = \frac{(122+104)}{2} =$ 113 F

Perhitungan Cp aliran panas (Cp_h) dengan menggunakan interpolasi

Rumus $Cp_h = \frac{Tdiketahui-Tatas}{Tbawah-Tatas}$ ((Cp_{atas}-Cp_{bawah})+Cp_{bawah}

$Cp_c = \frac{(113-100)\text{F}}{(130-100)\text{F}}$ ((4,174-4,179)+4,179) btu/kg F

= 1,808733 btu/kg F

m_h = 45 kg/det

Perhitungan kapasitas panas aliran panas (C_h)

Rumus $C_h = m_h$ x Cp_h

C_h = 45 kg/jam x 1,808733 btu/kg F

= 81,393 btu/jam F

Perhitungan laju perpindahan panas aliran panas (Q_h)

Rumus $Q_h = m_h$ x C_h x ΔT_h

Q_h = 45 kg/jam x 81,393 btu/jam F x 23,539 ^oF

= 86216,83 btu/jam

Perhitungan untuk mencari koefisien overall (Ud)

Rumus = A X UD X ΔTLMTD

UD = $\frac{Q}{A\ X \Delta \text{TLMTD}}$

UD $= \frac{86216,83}{7,618\ X\ 24,020}$

UD = 471,1727 btu kg/jamft^2 ^{o}F

UD Desain = 500 btu kg/jamft^2 ^{o}F